OIPE JC71
OCT 18 2004
PATENT & TRADEMARK OFFICE

BEST AVAILABLE COPY

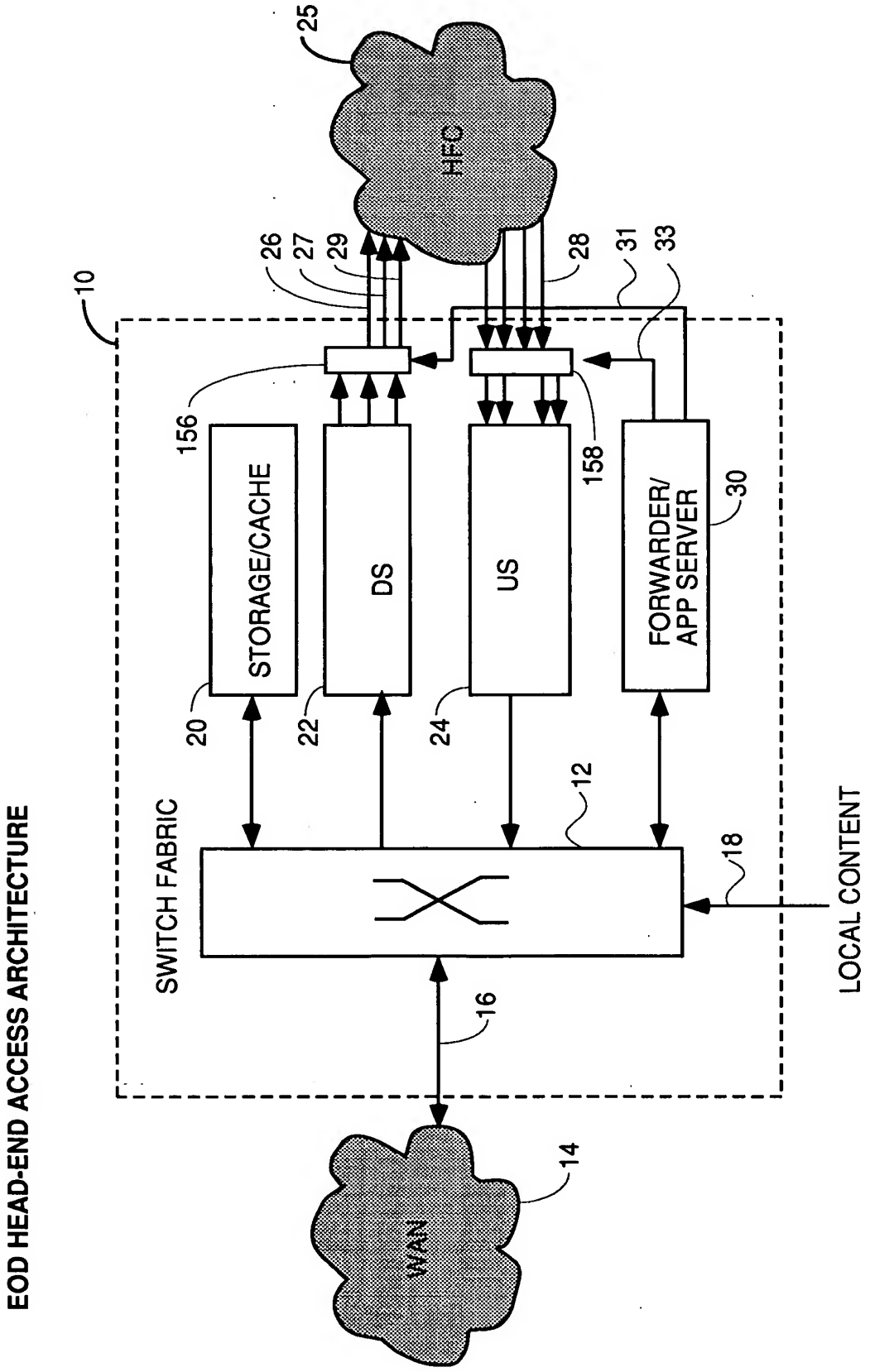


FIG. 1

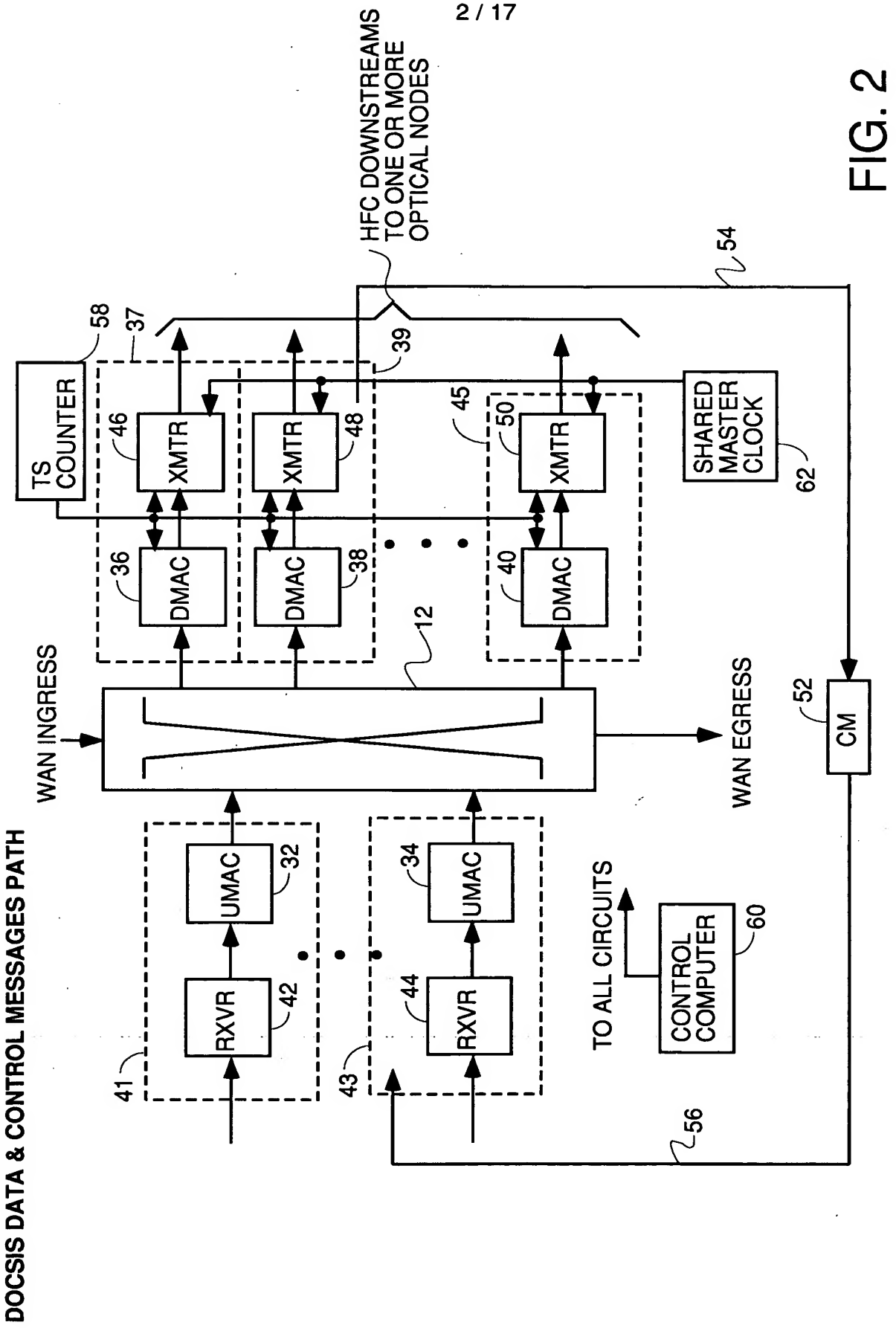
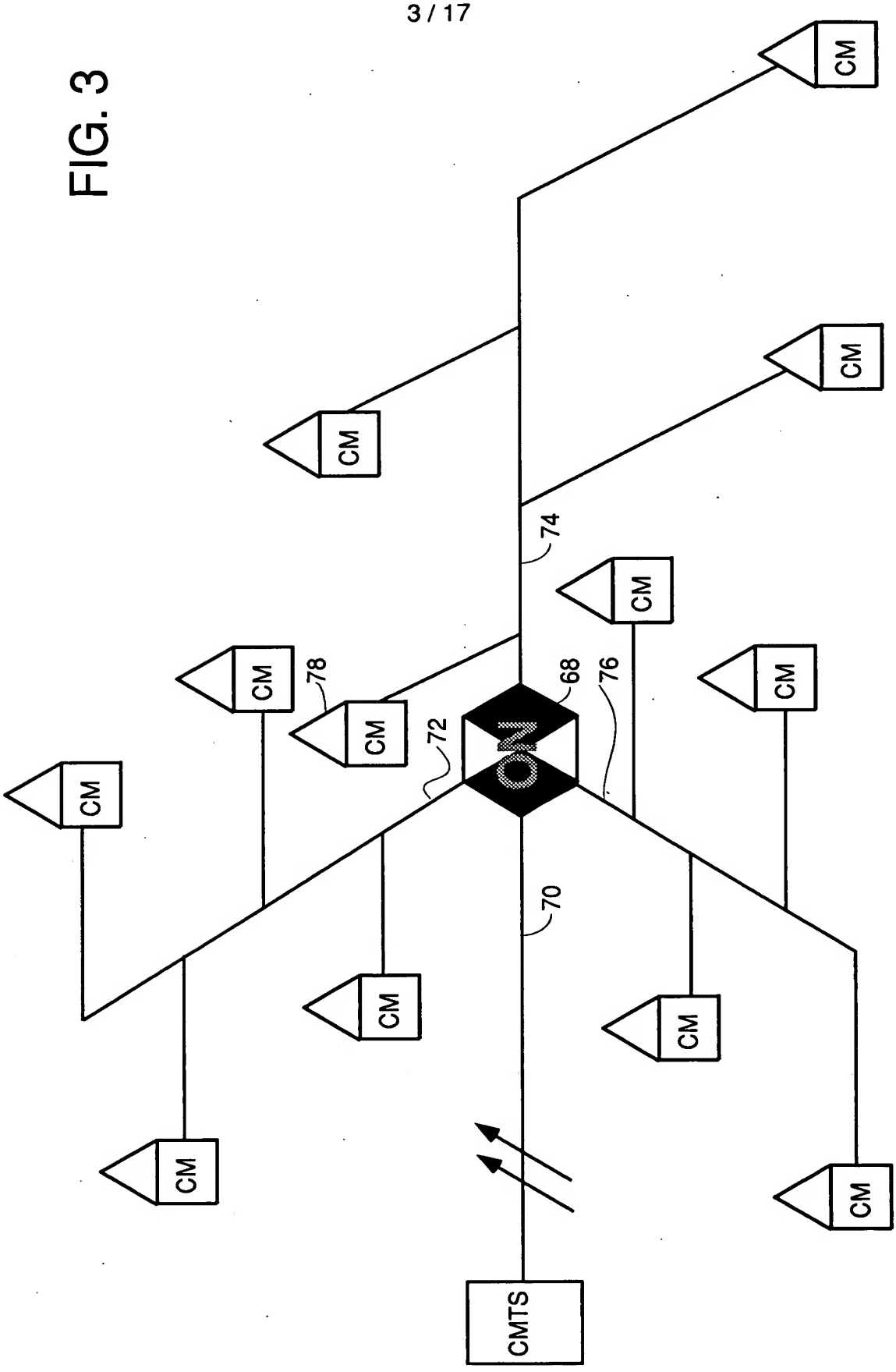

HFC DOWNSTREAMS TO ONE OR MORE OPTICAL NODES
54
58
37
39
TS COUNTER
46
XMTR
48
45
50
XMTR
SHARED MASTER CLOCK
62
36
DMAC
38
40
DMAC
12
WAN INGRESS
WAN EGRESS
52
CM
UMAC
32
34
UMAC
TO ALL CIRCUITS
CONTROL COMPUTER
60
RXVR
42
44
RXVR
41
43
56
DOCSIS DATA & CONTROL MESSAGES PATH

FIG. 2

FIG. 3



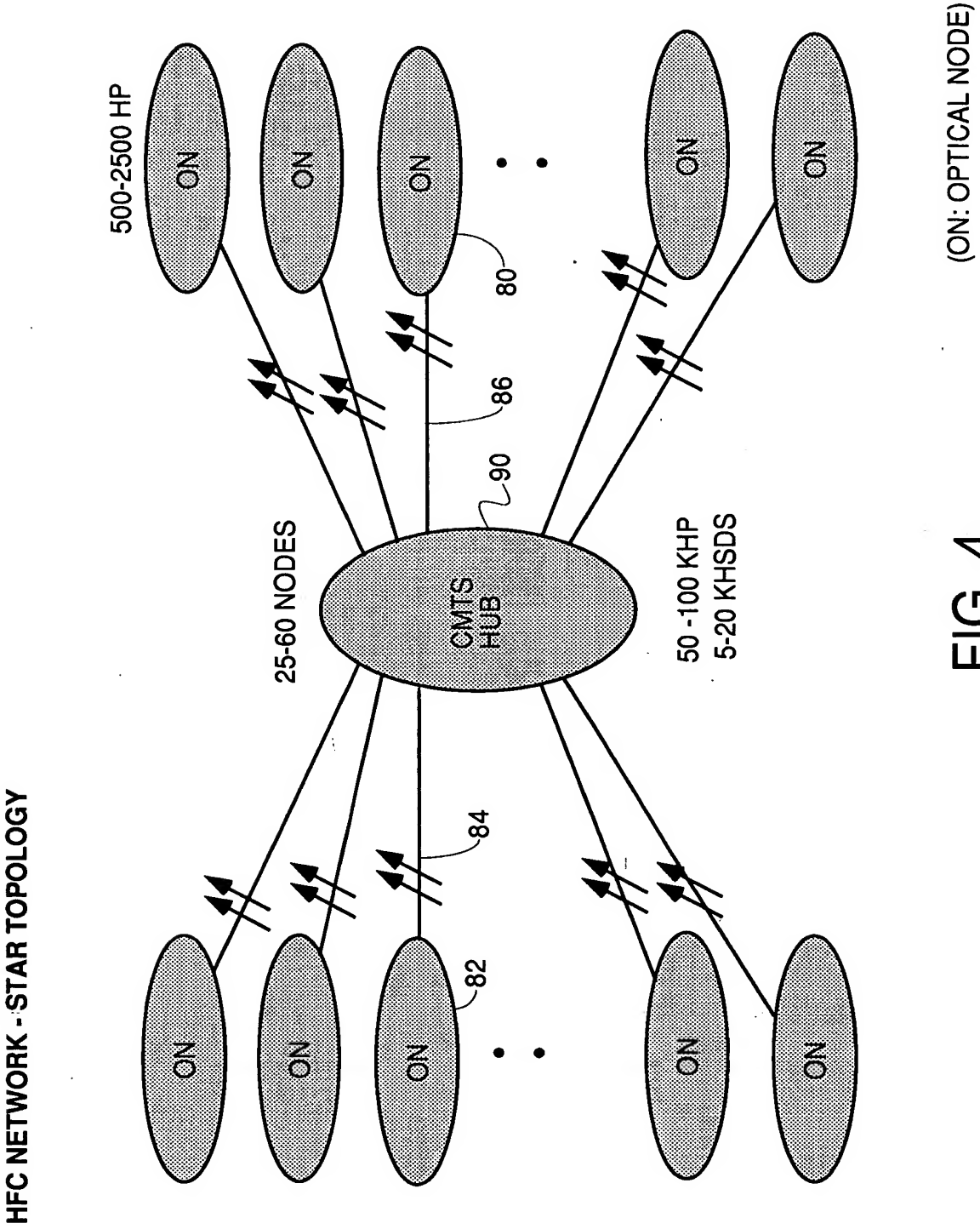

HFC NETWORK - STAR TOPOLOGY
500-2500 HP
ON
25-60 NODES
CMTS HUB
50 -100 KHP
5-20 KHSDS
80
86
90
84
82
(ON: OPTICAL NODE)

FIG. 4

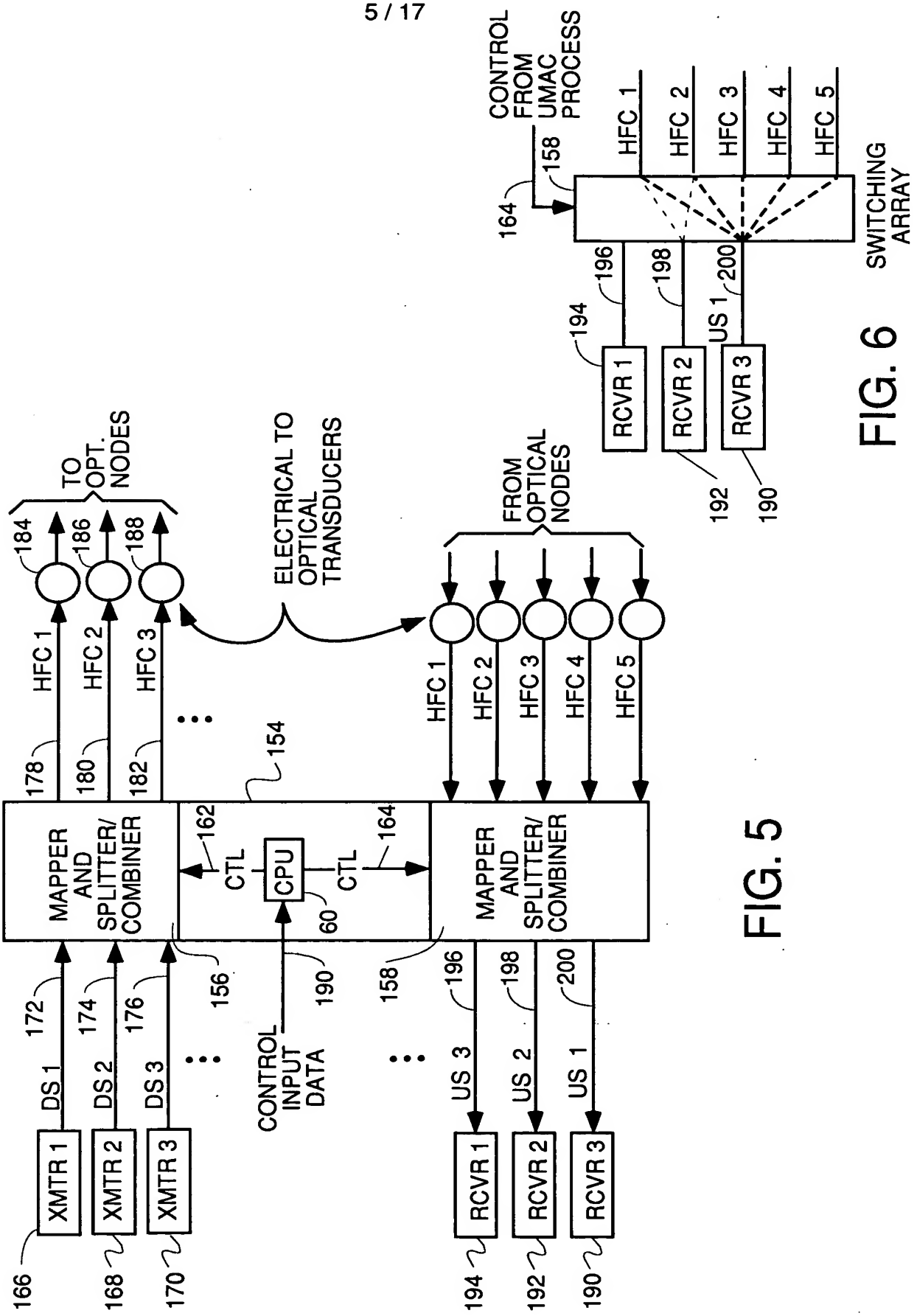

CONTROL FROM UMAC PROCESS
158
164
HFC 1
HFC 2
HFC 3
HFC 4
HFC 5
SWITCHING ARRAY
196
198
200
194
US 1
RCVR 1
RCVR 2
RCVR 3
192
190
TO OPT. NODES
184
186
188
ELECTRICAL TO OPTICAL TRANSDUCERS
FROM OPTICAL NODES
178
180
182
154
MAPPER AND SPLITTER/ COMBINER
162
CTL
CPU
60
CTL
164
172
174
176
DS 1
DS 2
DS 3
XMTR 1
XMTR 2
XMTR 3
166
168
170
156
190
CONTROL INPUT DATA
158
US 3
US 2
US 1

FIG. 6

FIG. 5

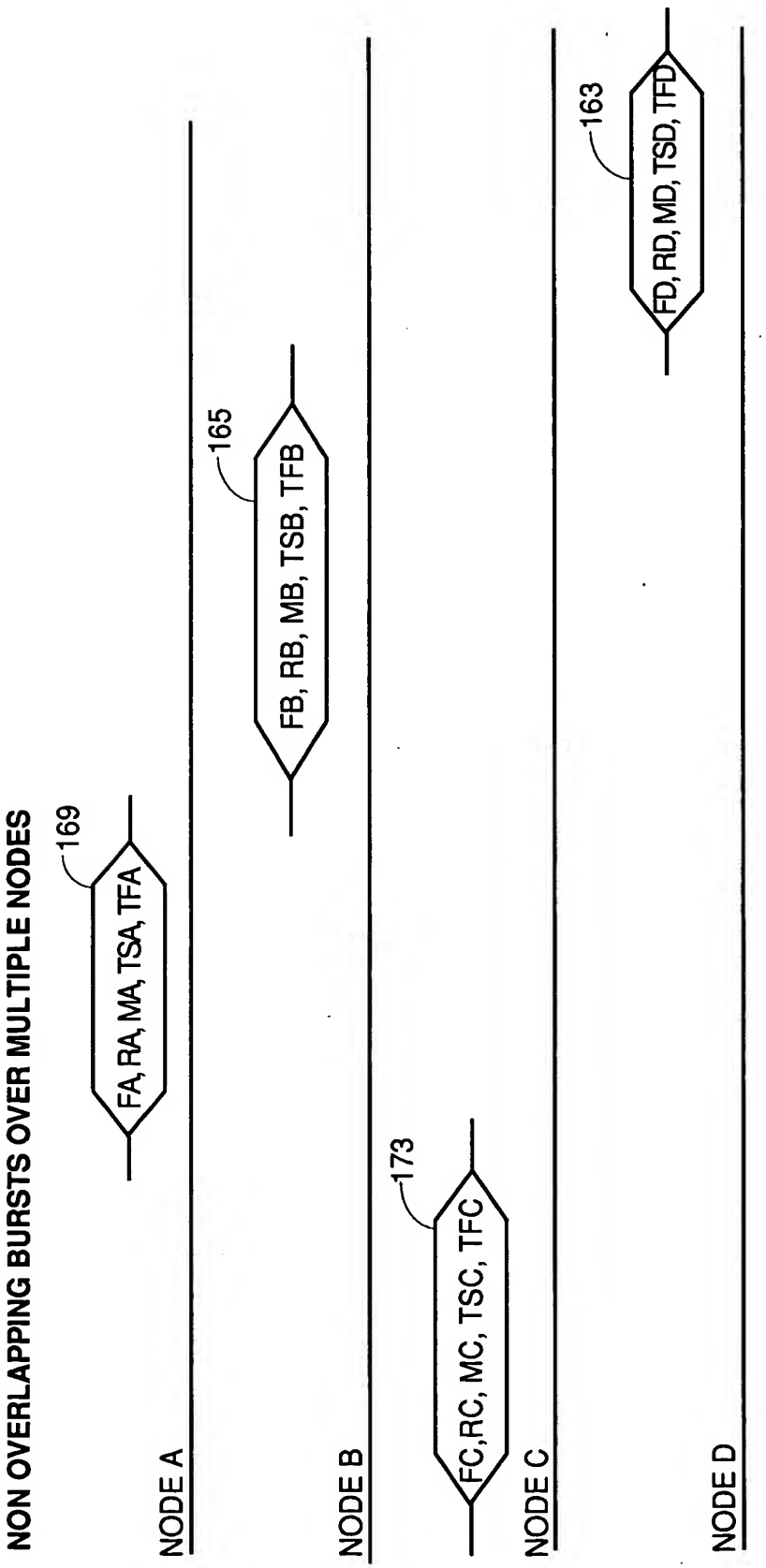

NON OVERLAPPING BURSTS OVER MULTIPLE NODES
NODE A
NODE B
NODE C
NODE D
169
FA, RA, MA, TSA, TFA
165
FB, RB, MB, TSB, TFB
173
FC,RC, MC, TSC, TFC
163
FD, RD, MD, TSD, TFD

FIG. 7

FC,RC, MC, TSC, TFC
FA, RA, MA, TSA, TFA
FB, RB, MB, TSB, TFB
FD, RD, MD, TSD, TFD

FIG. 8

PROCESS TO CREATE AND CHANGE US/DS MAPPING IN THE PRESENCE OF NOISE AGGREGATION

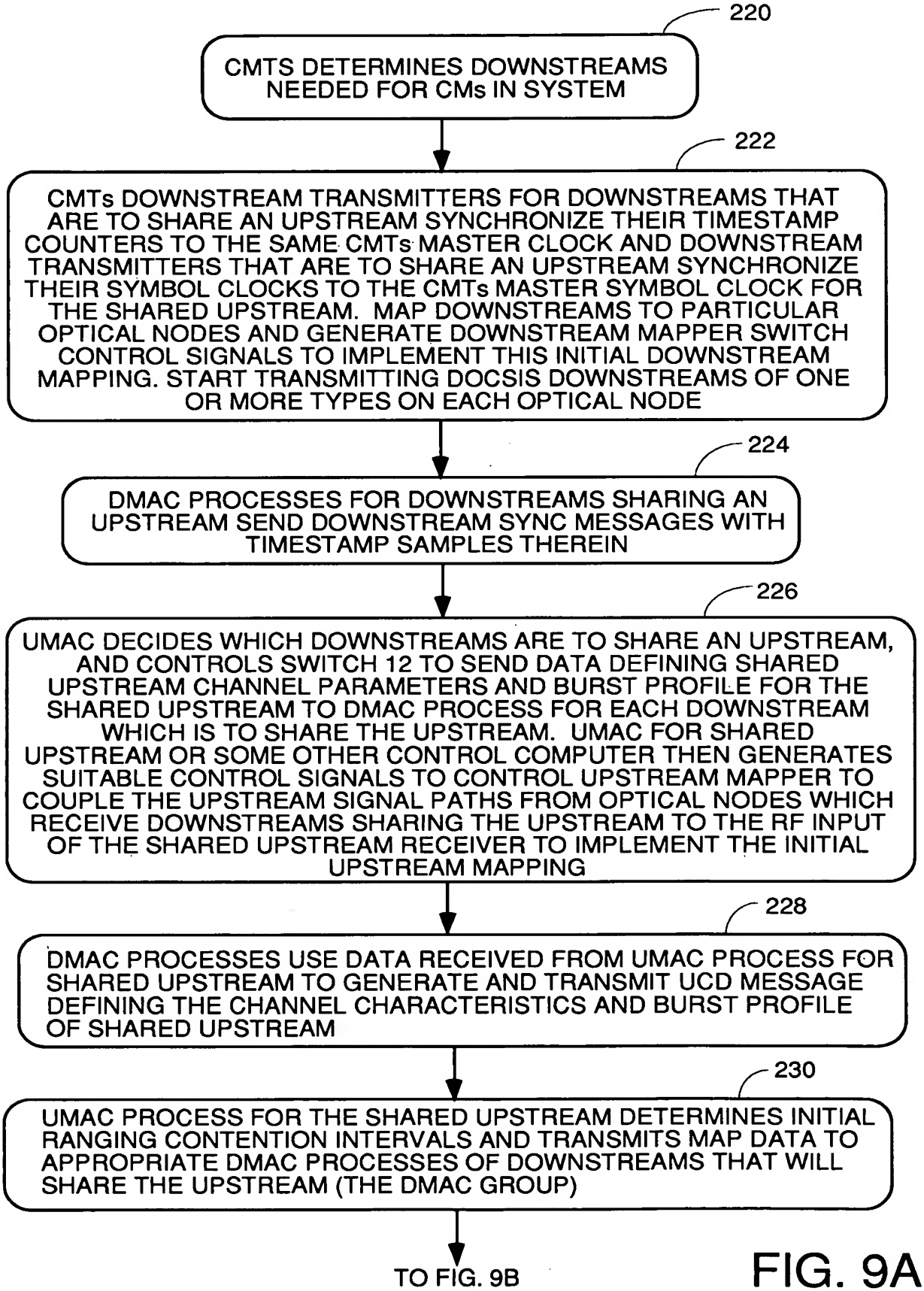


FIG. 9A

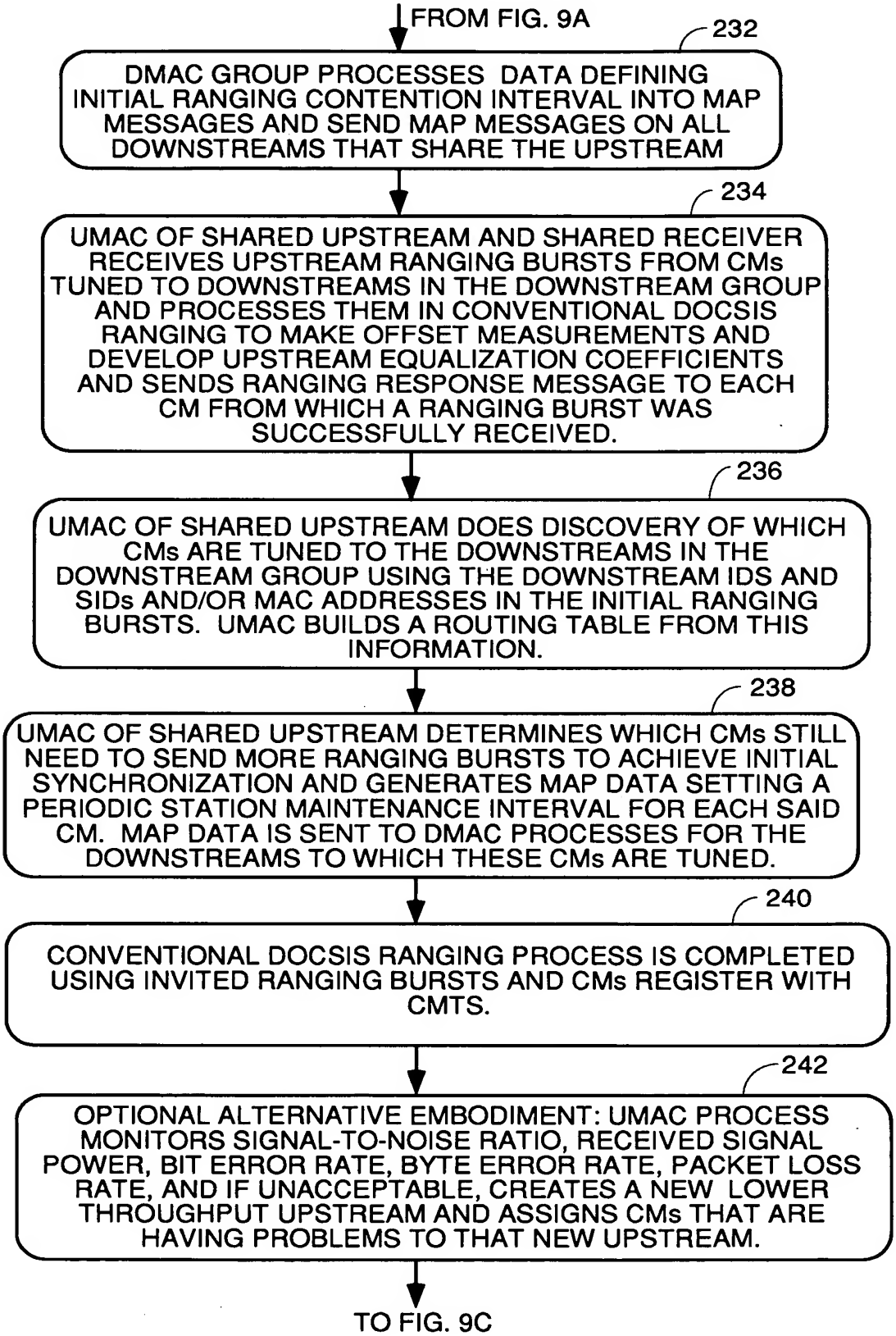

FROM FIG. 9A
232
DMAC GROUP PROCESSES DATA DEFINING INITIAL RANGING CONTENTION INTERVAL INTO MAP MESSAGES AND SEND MAP MESSAGES ON ALL DOWNSTREAMS THAT SHARE THE UPSTREAM
234
UMAC OF SHARED UPSTREAM AND SHARED RECEIVER RECEIVES UPSTREAM RANGING BURSTS FROM CMs TUNED TO DOWNSTREAMS IN THE DOWNSTREAM GROUP AND PROCESSES THEM IN CONVENTIONAL DOCSIS RANGING TO MAKE OFFSET MEASUREMENTS AND DEVELOP UPSTREAM EQUALIZATION COEFFICIENTS AND SENDS RANGING RESPONSE MESSAGE TO EACH CM FROM WHICH A RANGING BURST WAS SUCCESSFULLY RECEIVED.
236
UMAC OF SHARED UPSTREAM DOES DISCOVERY OF WHICH CMs ARE TUNED TO THE DOWNSTREAMS IN THE DOWNSTREAM GROUP USING THE DOWNSTREAM IDS AND SIDs AND/OR MAC ADDRESSES IN THE INITIAL RANGING BURSTS. UMAC BUILDS A ROUTING TABLE FROM THIS INFORMATION.
238
UMAC OF SHARED UPSTREAM DETERMINES WHICH CMs STILL NEED TO SEND MORE RANGING BURSTS TO ACHIEVE INITIAL SYNCHRONIZATION AND GENERATES MAP DATA SETTING A PERIODIC STATION MAINTENANCE INTERVAL FOR EACH SAID CM. MAP DATA IS SENT TO DMAC PROCESSES FOR THE DOWNSTREAMS TO WHICH THESE CMs ARE TUNED.
240
CONVENTIONAL DOCSIS RANGING PROCESS IS COMPLETED USING INVITED RANGING BURSTS AND CMs REGISTER WITH CMTS.
242
OPTIONAL ALTERNATIVE EMBODIMENT: UMAC PROCESS MONITORS SIGNAL-TO-NOISE RATIO, RECEIVED SIGNAL POWER, BIT ERROR RATE, BYTE ERROR RATE, PACKET LOSS RATE, AND IF UNACCEPTABLE, CREATES A NEW LOWER THROUGHPUT UPSTREAM AND ASSIGNS CMs THAT ARE HAVING PROBLEMS TO THAT NEW UPSTREAM.
TO FIG. 9C

FIG. 9B

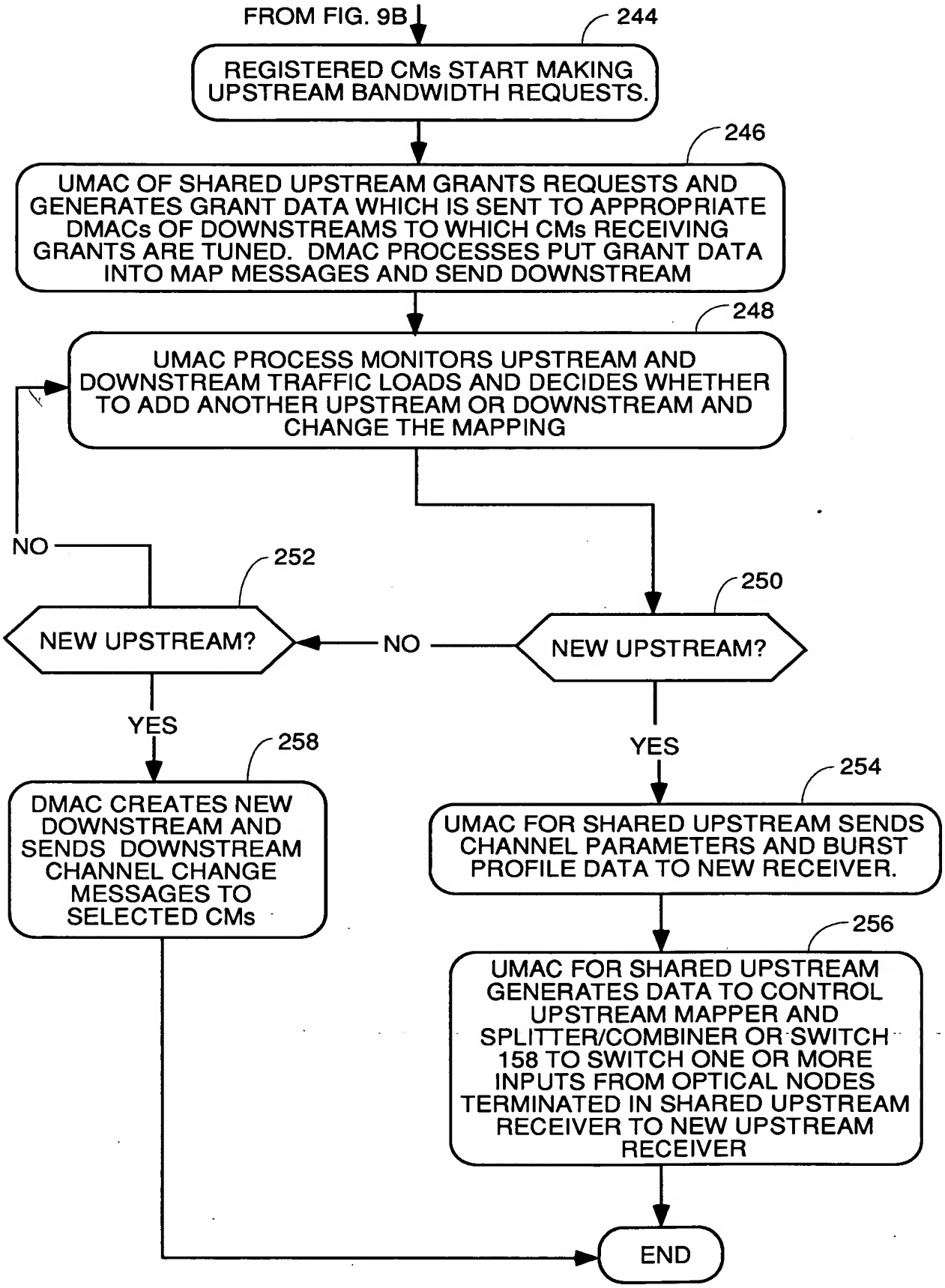

FROM FIG. 9B
244
REGISTERED CMs START MAKING UPSTREAM BANDWIDTH REQUESTS.
246
UMAC OF SHARED UPSTREAM GRANTS REQUESTS AND GENERATES GRANT DATA WHICH IS SENT TO APPROPRIATE DMACs OF DOWNSTREAMS TO WHICH CMs RECEIVING GRANTS ARE TUNED. DMAC PROCESSES PUT GRANT DATA INTO MAP MESSAGES AND SEND DOWNSTREAM
248
UMAC PROCESS MONITORS UPSTREAM AND DOWNSTREAM TRAFFIC LOADS AND DECIDES WHETHER TO ADD ANOTHER UPSTREAM OR DOWNSTREAM AND CHANGE THE MAPPING
NO
252
NEW UPSTREAM?
NO
250
NEW UPSTREAM?
YES
258
DMAC CREATES NEW DOWNSTREAM AND SENDS DOWNSTREAM CHANNEL CHANGE MESSAGES TO SELECTED CMs
YES
254
UMAC FOR SHARED UPSTREAM SENDS CHANNEL PARAMETERS AND BURST PROFILE DATA TO NEW RECEIVER.
256
UMAC FOR SHARED UPSTREAM GENERATES DATA TO CONTROL UPSTREAM MAPPER AND SPLITTER/COMBINER OR SWITCH 158 TO SWITCH ONE OR MORE INPUTS FROM OPTICAL NODES TERMINATED IN SHARED UPSTREAM RECEIVER TO NEW UPSTREAM RECEIVER
END

FIG. 9C

PROCESS TO CREATE AND CHANGE US/DS MAPPING IN THE PRESENCE OF NOISE AGGREGATION

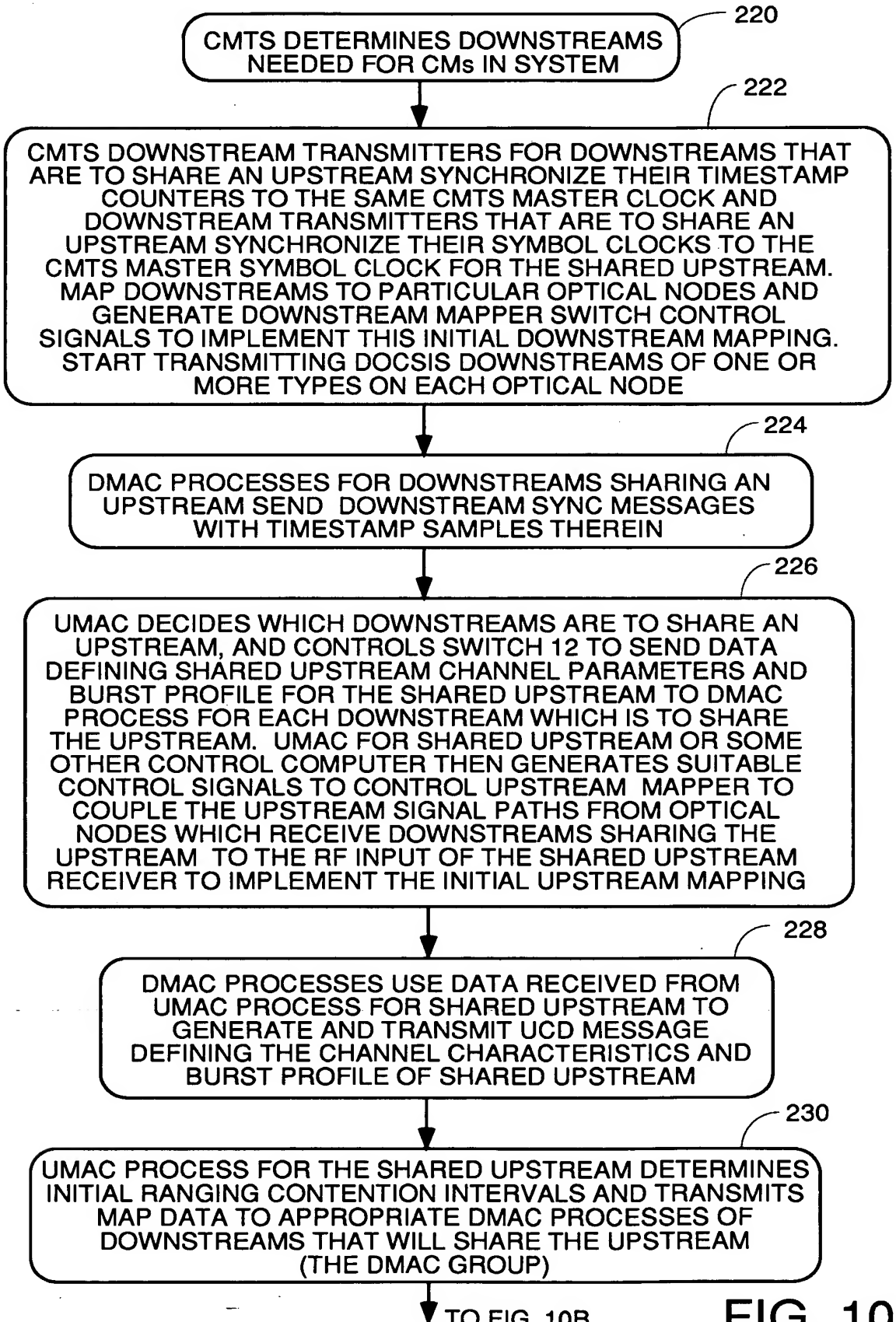


FIG. 10A

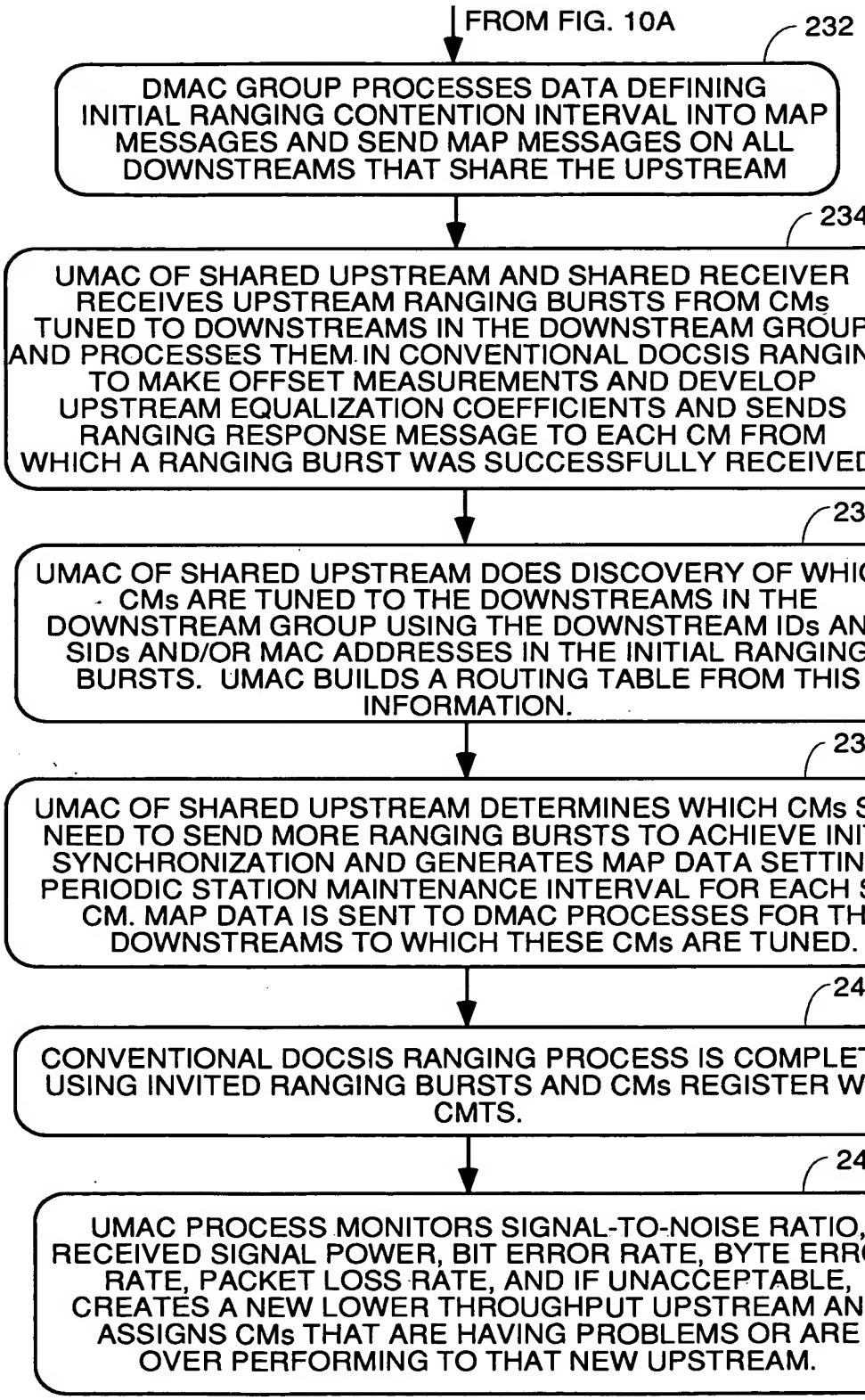

FROM FIG. 10A
232
DMAC GROUP PROCESSES DATA DEFINING INITIAL RANGING CONTENTION INTERVAL INTO MAP MESSAGES AND SEND MAP MESSAGES ON ALL DOWNSTREAMS THAT SHARE THE UPSTREAM
234
UMAC OF SHARED UPSTREAM AND SHARED RECEIVER RECEIVES UPSTREAM RANGING BURSTS FROM CMs TUNED TO DOWNSTREAMS IN THE DOWNSTREAM GROUP AND PROCESSES THEM IN CONVENTIONAL DOCSIS RANGING TO MAKE OFFSET MEASUREMENTS AND DEVELOP UPSTREAM EQUALIZATION COEFFICIENTS AND SENDS RANGING RESPONSE MESSAGE TO EACH CM FROM WHICH A RANGING BURST WAS SUCCESSFULLY RECEIVED.
236
UMAC OF SHARED UPSTREAM DOES DISCOVERY OF WHICH CMs ARE TUNED TO THE DOWNSTREAMS IN THE DOWNSTREAM GROUP USING THE DOWNSTREAM IDs AND SIDs AND/OR MAC ADDRESSES IN THE INITIAL RANGING BURSTS. UMAC BUILDS A ROUTING TABLE FROM THIS INFORMATION.
238
UMAC OF SHARED UPSTREAM DETERMINES WHICH CMs STILL NEED TO SEND MORE RANGING BURSTS TO ACHIEVE INITIAL SYNCHRONIZATION AND GENERATES MAP DATA SETTING A PERIODIC STATION MAINTENANCE INTERVAL FOR EACH SAID CM. MAP DATA IS SENT TO DMAC PROCESSES FOR THE DOWNSTREAMS TO WHICH THESE CMs ARE TUNED.
240
CONVENTIONAL DOCSIS RANGING PROCESS IS COMPLETED USING INVITED RANGING BURSTS AND CMs REGISTER WITH CMTS.
242
UMAC PROCESS MONITORS SIGNAL-TO-NOISE RATIO, RECEIVED SIGNAL POWER, BIT ERROR RATE, BYTE ERROR RATE, PACKET LOSS RATE, AND IF UNACCEPTABLE, CREATES A NEW LOWER THROUGHPUT UPSTREAM AND ASSIGNS CMs THAT ARE HAVING PROBLEMS OR ARE OVER PERFORMING TO THAT NEW UPSTREAM.

FIG. 10B

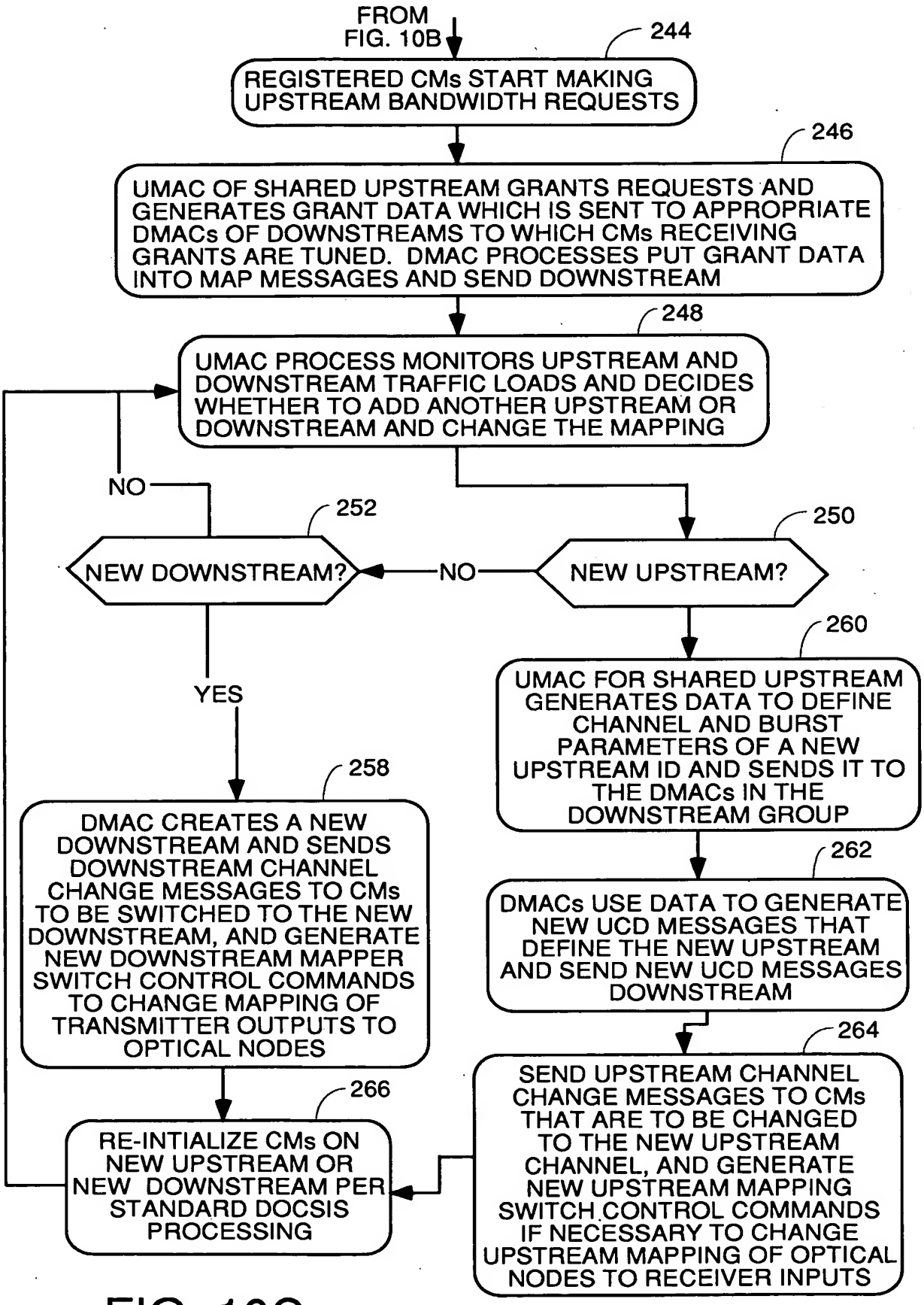

FROM FIG. 10B
244
REGISTERED CMs START MAKING UPSTREAM BANDWIDTH REQUESTS
246
UMAC OF SHARED UPSTREAM GRANTS REQUESTS AND GENERATES GRANT DATA WHICH IS SENT TO APPROPRIATE DMACs OF DOWNSTREAMS TO WHICH CMs RECEIVING GRANTS ARE TUNED. DMAC PROCESSES PUT GRANT DATA INTO MAP MESSAGES AND SEND DOWNSTREAM
248
UMAC PROCESS MONITORS UPSTREAM AND DOWNSTREAM TRAFFIC LOADS AND DECIDES WHETHER TO ADD ANOTHER UPSTREAM OR DOWNSTREAM AND CHANGE THE MAPPING
NO
252
NEW DOWNSTREAM?
NO
250
NEW UPSTREAM?
YES
260
UMAC FOR SHARED UPSTREAM GENERATES DATA TO DEFINE CHANNEL AND BURST PARAMETERS OF A NEW UPSTREAM ID AND SENDS IT TO THE DMACs IN THE DOWNSTREAM GROUP
258
DMAC CREATES A NEW DOWNSTREAM AND SENDS DOWNSTREAM CHANNEL CHANGE MESSAGES TO CMs TO BE SWITCHED TO THE NEW DOWNSTREAM, AND GENERATE NEW DOWNSTREAM MAPPER SWITCH CONTROL COMMANDS TO CHANGE MAPPING OF TRANSMITTER OUTPUTS TO OPTICAL NODES
262
DMACs USE DATA TO GENERATE NEW UCD MESSAGES THAT DEFINE THE NEW UPSTREAM AND SEND NEW UCD MESSAGES DOWNSTREAM
264
SEND UPSTREAM CHANNEL CHANGE MESSAGES TO CMs THAT ARE TO BE CHANGED TO THE NEW UPSTREAM CHANNEL, AND GENERATE NEW UPSTREAM MAPPING SWITCH CONTROL COMMANDS IF NECESSARY TO CHANGE UPSTREAM MAPPING OF OPTICAL NODES TO RECEIVER INPUTS
266
RE-INTIALIZE CMs ON NEW UPSTREAM OR NEW DOWNSTREAM PER STANDARD DOCSIS PROCESSING

FIG. 10C

PROCESS TO CREATE AND CHANGE US/DS MAPPING WITHOUT NOISE AGGREGATION

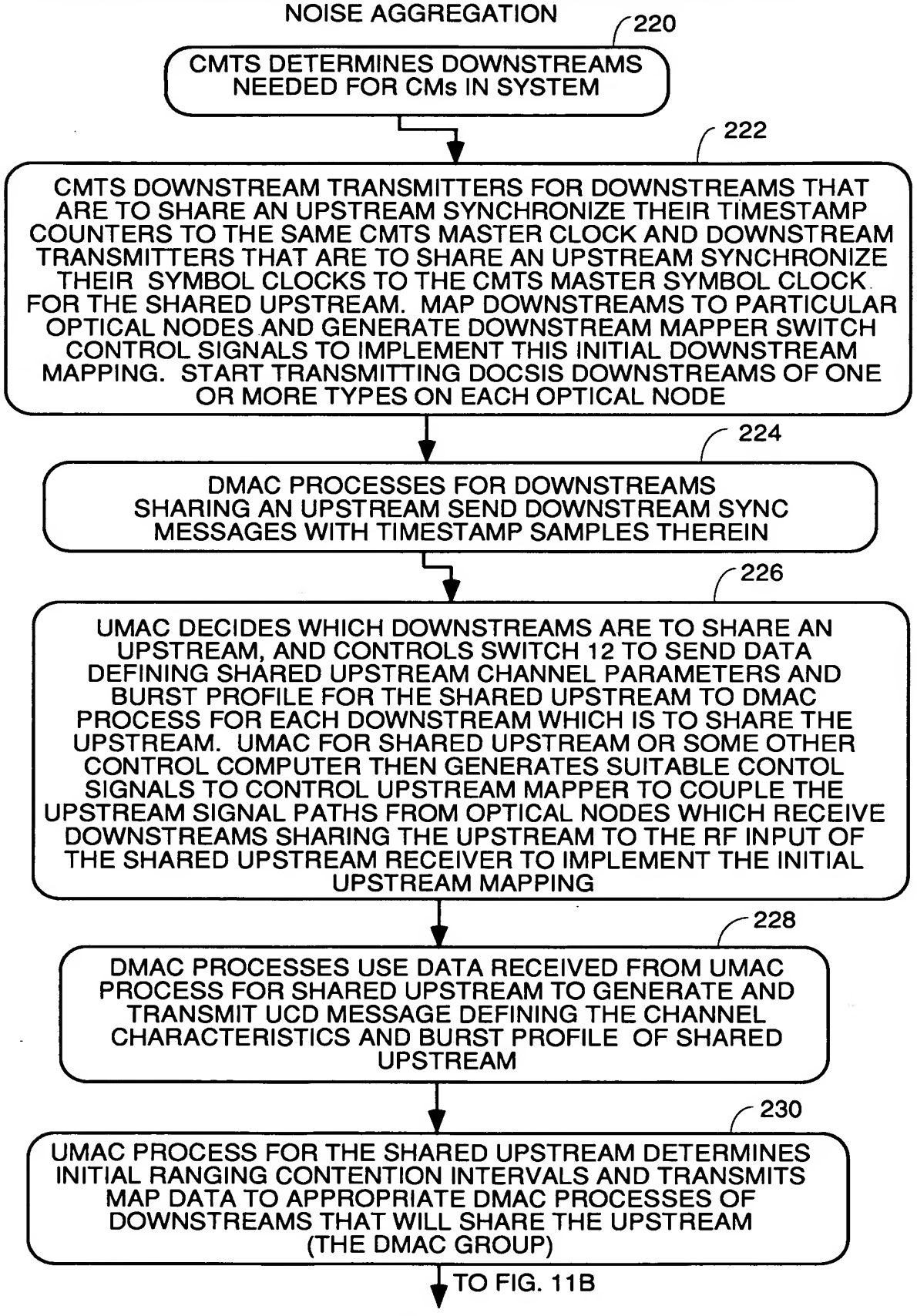


FIG. 11A

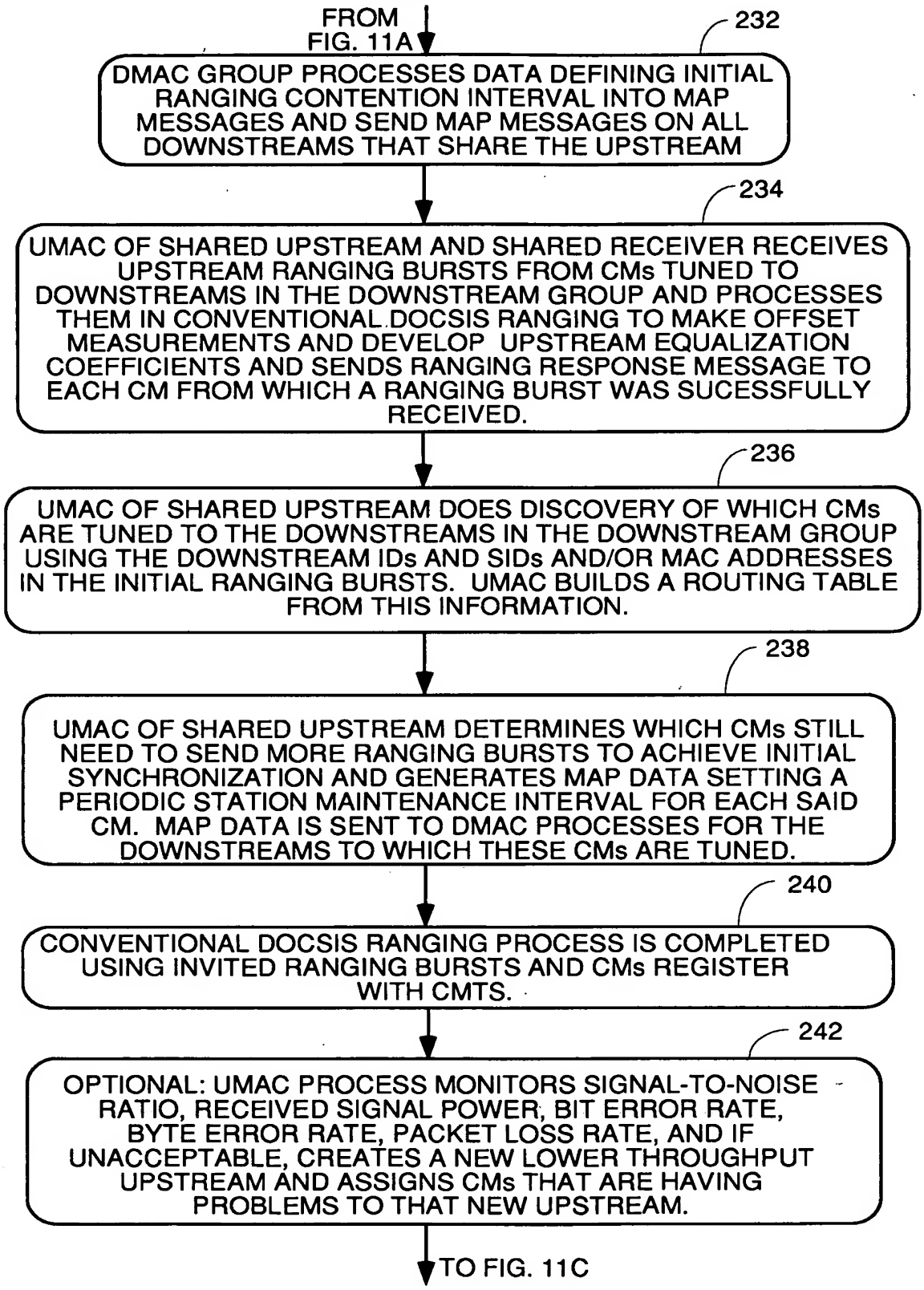
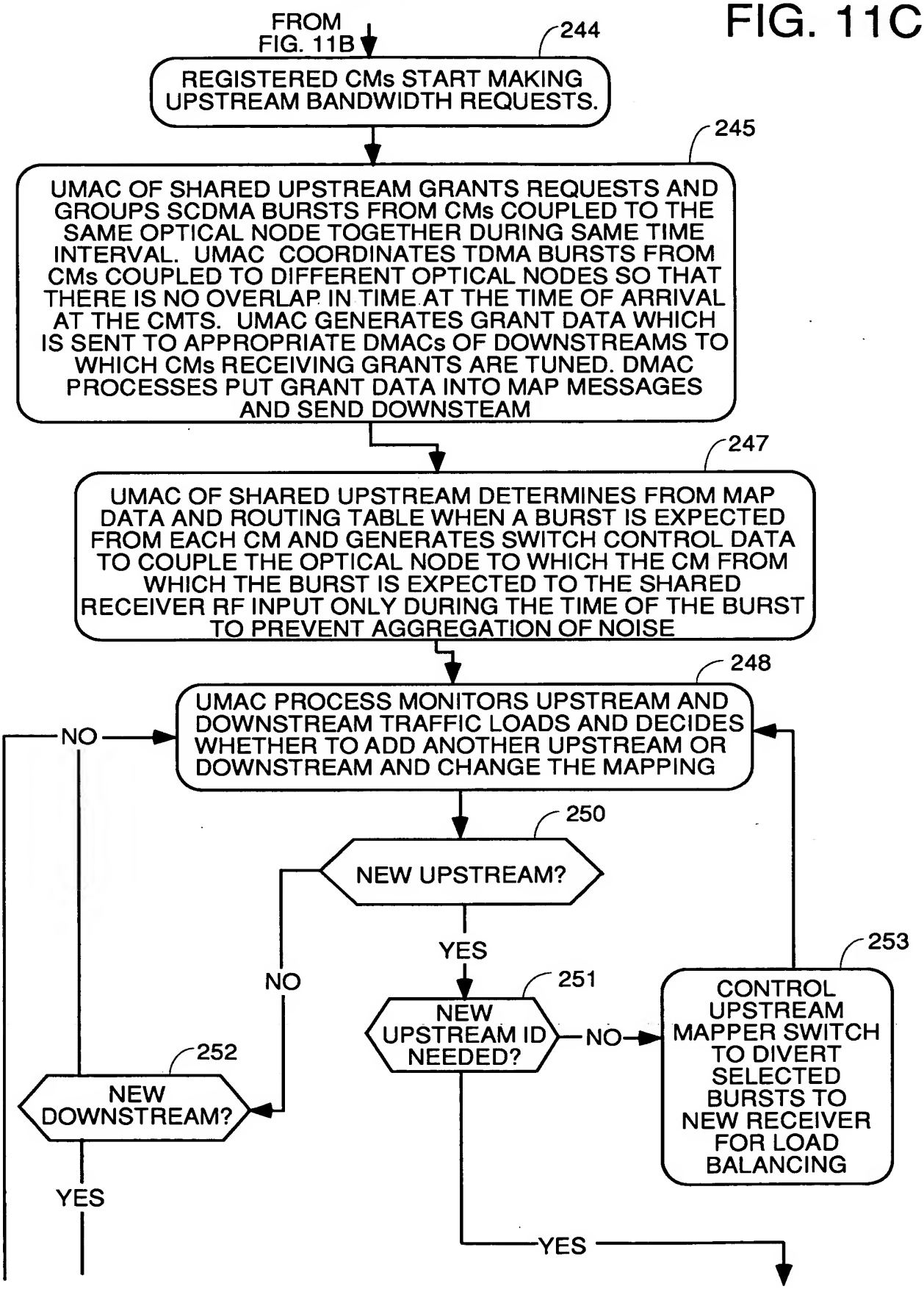

FROM FIG. 11A
232
DMAC GROUP PROCESSES DATA DEFINING INITIAL RANGING CONTENTION INTERVAL INTO MAP MESSAGES AND SEND MAP MESSAGES ON ALL DOWNSTREAMS THAT SHARE THE UPSTREAM
234
UMAC OF SHARED UPSTREAM AND SHARED RECEIVER RECEIVES UPSTREAM RANGING BURSTS FROM CMs TUNED TO DOWNSTREAMS IN THE DOWNSTREAM GROUP AND PROCESSES THEM IN CONVENTIONAL DOCSIS RANGING TO MAKE OFFSET MEASUREMENTS AND DEVELOP UPSTREAM EQUALIZATION COEFFICIENTS AND SENDS RANGING RESPONSE MESSAGE TO EACH CM FROM WHICH A RANGING BURST WAS SUCESSFULLY RECEIVED.
236
UMAC OF SHARED UPSTREAM DOES DISCOVERY OF WHICH CMs ARE TUNED TO THE DOWNSTREAMS IN THE DOWNSTREAM GROUP USING THE DOWNSTREAM IDs AND SIDs AND/OR MAC ADDRESSES IN THE INITIAL RANGING BURSTS. UMAC BUILDS A ROUTING TABLE FROM THIS INFORMATION.
238
UMAC OF SHARED UPSTREAM DETERMINES WHICH CMs STILL NEED TO SEND MORE RANGING BURSTS TO ACHIEVE INITIAL SYNCHRONIZATION AND GENERATES MAP DATA SETTING A PERIODIC STATION MAINTENANCE INTERVAL FOR EACH SAID CM. MAP DATA IS SENT TO DMAC PROCESSES FOR THE DOWNSTREAMS TO WHICH THESE CMs ARE TUNED.
240
CONVENTIONAL DOCSIS RANGING PROCESS IS COMPLETED USING INVITED RANGING BURSTS AND CMs REGISTER WITH CMTS.
242
OPTIONAL: UMAC PROCESS MONITORS SIGNAL-TO-NOISE RATIO, RECEIVED SIGNAL POWER, BIT ERROR RATE, BYTE ERROR RATE, PACKET LOSS RATE, AND IF UNACCEPTABLE, CREATES A NEW LOWER THROUGHPUT UPSTREAM AND ASSIGNS CMs THAT ARE HAVING PROBLEMS TO THAT NEW UPSTREAM.
TO FIG. 11C

FIG. 11B

FIG. 11C


FROM FIG. 11B
244
REGISTERED CMs START MAKING UPSTREAM BANDWIDTH REQUESTS.
245
UMAC OF SHARED UPSTREAM GRANTS REQUESTS AND GROUPS SCDMA BURSTS FROM CMs COUPLED TO THE SAME OPTICAL NODE TOGETHER DURING SAME TIME INTERVAL. UMAC COORDINATES TDMA BURSTS FROM CMs COUPLED TO DIFFERENT OPTICAL NODES SO THAT THERE IS NO OVERLAP IN TIME AT THE TIME OF ARRIVAL AT THE CMTS. UMAC GENERATES GRANT DATA WHICH IS SENT TO APPROPRIATE DMACs OF DOWNSTREAMS TO WHICH CMs RECEIVING GRANTS ARE TUNED. DMAC PROCESSES PUT GRANT DATA INTO MAP MESSAGES AND SEND DOWNSTEAM
247
UMAC OF SHARED UPSTREAM DETERMINES FROM MAP DATA AND ROUTING TABLE WHEN A BURST IS EXPECTED FROM EACH CM AND GENERATES SWITCH CONTROL DATA TO COUPLE THE OPTICAL NODE TO WHICH THE CM FROM WHICH THE BURST IS EXPECTED TO THE SHARED RECEIVER RF INPUT ONLY DURING THE TIME OF THE BURST TO PREVENT AGGREGATION OF NOISE
248
UMAC PROCESS MONITORS UPSTREAM AND DOWNSTREAM TRAFFIC LOADS AND DECIDES WHETHER TO ADD ANOTHER UPSTREAM OR DOWNSTREAM AND CHANGE THE MAPPING
NO
250
NEW UPSTREAM?
YES
NO
251
NEW UPSTREAM ID NEEDED?
NO
253
CONTROL UPSTREAM MAPPER SWITCH TO DIVERT SELECTED BURSTS TO NEW RECEIVER FOR LOAD BALANCING
252
NEW DOWNSTREAM?
YES
YES

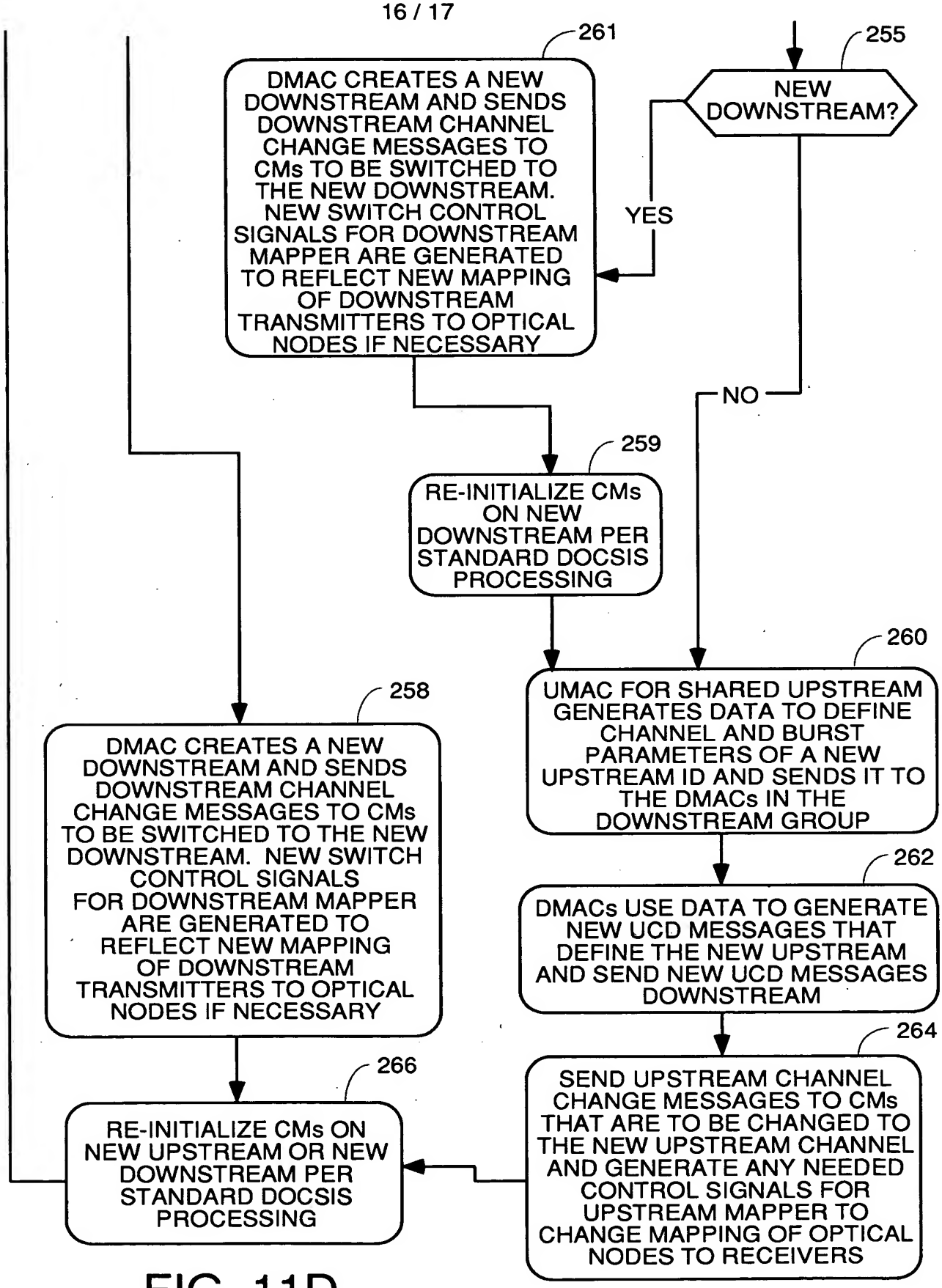

261
DMAC CREATES A NEW DOWNSTREAM AND SENDS DOWNSTREAM CHANNEL CHANGE MESSAGES TO CMs TO BE SWITCHED TO THE NEW DOWNSTREAM. NEW SWITCH CONTROL SIGNALS FOR DOWNSTREAM MAPPER ARE GENERATED TO REFLECT NEW MAPPING OF DOWNSTREAM TRANSMITTERS TO OPTICAL NODES IF NECESSARY
255
NEW DOWNSTREAM?
YES
NO
259
RE-INITIALIZE CMs ON NEW DOWNSTREAM PER STANDARD DOCSIS PROCESSING
260
UMAC FOR SHARED UPSTREAM GENERATES DATA TO DEFINE CHANNEL AND BURST PARAMETERS OF A NEW UPSTREAM ID AND SENDS IT TO THE DMACs IN THE DOWNSTREAM GROUP
258
DMAC CREATES A NEW DOWNSTREAM AND SENDS DOWNSTREAM CHANNEL CHANGE MESSAGES TO CMs TO BE SWITCHED TO THE NEW DOWNSTREAM. NEW SWITCH CONTROL SIGNALS FOR DOWNSTREAM MAPPER ARE GENERATED TO REFLECT NEW MAPPING OF DOWNSTREAM TRANSMITTERS TO OPTICAL NODES IF NECESSARY
262
DMACs USE DATA TO GENERATE NEW UCD MESSAGES THAT DEFINE THE NEW UPSTREAM AND SEND NEW UCD MESSAGES DOWNSTREAM
264
SEND UPSTREAM CHANNEL CHANGE MESSAGES TO CMs THAT ARE TO BE CHANGED TO THE NEW UPSTREAM CHANNEL AND GENERATE ANY NEEDED CONTROL SIGNALS FOR UPSTREAM MAPPER TO CHANGE MAPPING OF OPTICAL NODES TO RECEIVERS
266
RE-INITIALIZE CMs ON NEW UPSTREAM OR NEW DOWNSTREAM PER STANDARD DOCSIS PROCESSING

FIG. 11D

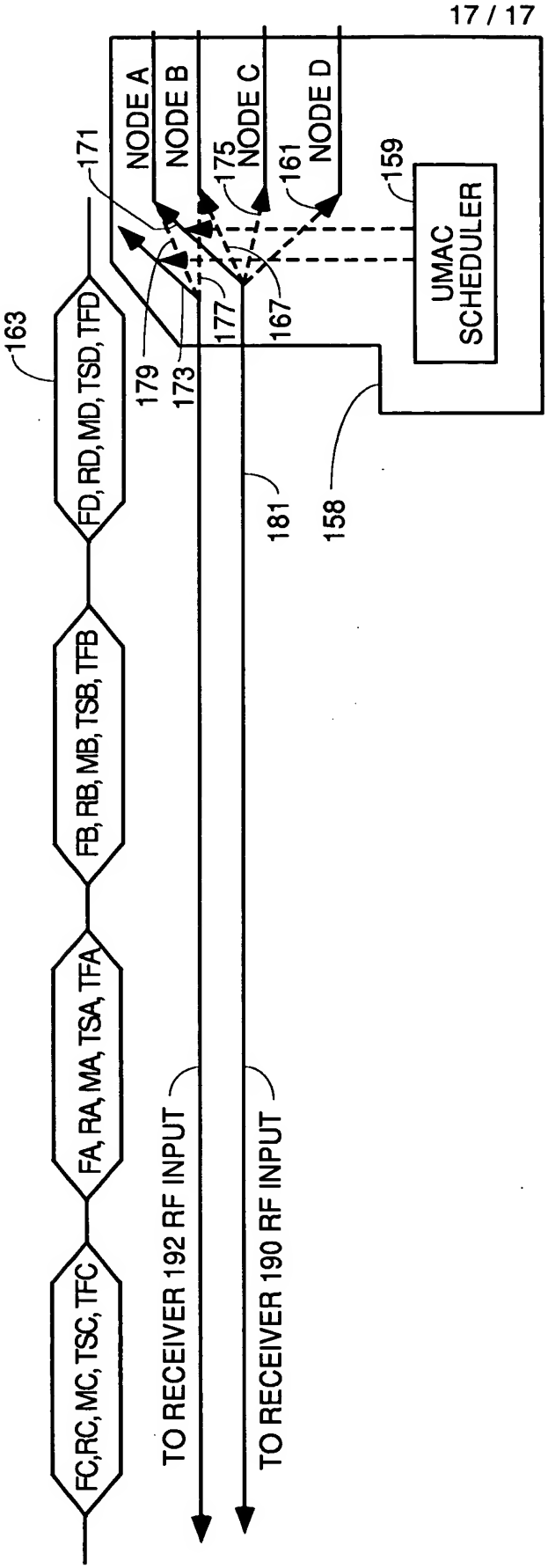

NODE A
NODE B
NODE C
NODE D
UMAC SCHEDULER
171
175
161
159
163
179
173
177
167
181
158
FD, RD, MD, TSD, TFD
FB, RB, MB, TSB, TFB
FA, RA, MA, TSA, TFA
FC, RC, MC, TSC, TFC
TO RECEIVER 192 RF INPUT
TO RECEIVER 190 RF INPUT

FIG. 12